LIGHT SCATTERING IN GASES
(*A Note*)

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ABSTRACT. The note gives depolarisation factors for a large number of gases after due correction of the earlier values obtained by the author, for the convergence of the lens used.

In a paper on the relation between light scattering and molecular structures, published several years ago, the author (Parthasarethy, 1932) gave factors of depolarisation only as measured, leaving out of account the error due to convergence of the beam, as there were differences of opinion then (Gans, 1927 ; Rao, 1927) on this subject. It is fairly well-established now that corrections have to be made for such convergence of the beam and when the values in the author's earlier paper were corrected for convergence, the data given in the present note would be obtained.

The author (Parthasarathy, 1932) mentioned that the lens used was of focal length 12″ and diameter 3″. The convergence correction due to this alone would be 0.77 %. But the apertures were placed in all the arms to avoid reflection from the inner portion of the tube. The aperture nearer the glass window of the arm through which light was focused, cut off light still further and the final correction came to nearly 0.5 %. Table I gives the values of depolarisation factors for the gases after due correction for convergence has been made.

TABLE I

Substance	Chemical formula	Corrected values %
Organic		
Methane from cylinder and corrected	CH_4	0.64
Pure gas		0.62
Ethane	C_2H_6	0 80
Propane	C_3H_8	1.01
Butane	C_4H_{10}	1.01
Isobutane	C_4H_{10}	0.53
Ethylene	C_2H_4	2.42
Acetylene	C_2H_2	4.02
Methyl chloride	CH_3Cl	1.54
Methylene chloride	CH_2Cl_2	2.43
Chloroform	$CHCl_3$	1.28
Carbon tetrachloride	CCl_4	0.12

TABLE I (*contd.*)

Substance	Chemical formula	Corrected values %
Organic (continued)		
Methylamine	CH_3NH_2	0.27
Ethylamine	$C_2H_5NH_2$	0.47
Formaldehyde	H.CHO	1.38
Acetaldehyde	CH_3.CHO	2.18
Methyl ether	CH_3-O CH_3	1.06
Ethyl ether	C_2H_5-O-C_2H_5	2.01
Acetone	CH_3.CO.CH_3	1 12
Allyl alcohol	CH_2.CH.CH_2OH	1.90
Inorganic gases,		
Air	...	3.65
Oxygen	O_2	6.00
Nitrogen	N_2	3.05
Hydrogen (from cylinder and corrected)	H_2	2.21
Pure gas	...	2 07
Chlorine	Cl_2	3.57
Carbon dioxide	CO_2	9.22
Nitrous oxide	N_2O	11.97
Hydrochloric acid gas ...	HCl	0.21
Hydrobromic acid gas ...	HBr	0.34
Hydriodic acid gas	HI	0.77
Nitric oxide (gas by both methods)	NO	2.18
Carbon monoxide	CO	0.80
Ammonia	NH_3	0.48
Hydrogen sulphide	H_2S	0 43
Sulphur dioxide	SO_2	2.61
Carbonyl sulphide	COS	8.27
Silicon tetrachloride	$SiCl_4$	1.14
Silicon tetrafluoride	SiF_4	2.61

TABLE I (*contd.*)

Substance	Chemical formula	Corrected values %
Inorganic gases (Contd.)		
Argon (uncorrected for impurities)	A	0.21
(corrected for impurities)	...	0.06
Helium	He	2.50

The main conclusions, after correction, may be stated as below:

(1) The anisotropy for argon (and possibly for other rare gases also) vanishes and the structure is therefore in conformity with evidence adduced by other methods.

(2) The optical anisotropy for CCl_4 vapour is vanishingly small, while

for CH_4 the depolarisation has a definite, though low, value of 0.62%. This does not mean anything, taken apart from other tetrahedral molecules, as the value is too low to be taken as a factor indicative of the optical anisotropy, but considering that even other molecules of RX_4 type, *e.g.* $SiCl_4$, SiF_4 show greater depolarisation (ρ), this calls for an explanation. The author's observation, that with relative sizes of R and X atoms, the factor ρ increases or decreases still holds good and it should be pointed out that, apart from the fact that ρ arises from mere geometry of form, there must also be some other factor which gives rise to it. To say that it might arise from the bigness of the molecules is out of the question, as the molecules itself is very small compared with the wave-length of light used, but the reason is to be sought elsewhere.

The above observations are further supported by Bhagavantam (1932) who studied the Raman effect in molecules of this type. He finds that the symmetrical vibration in such type of molecules is polarised to different extent in the following series of liquids, in addition to there being rotational wings accompanying the Rayleigh line :

Liquids	Raman frequency $\Delta\nu$	ρ
CCl_4	459	4 %
$SiCl_4$	426	11 %
$TiCl_4$	382	12 %
$SnCl_4$	367	16 %

Here the central atom increases in size, keeping X constant, in this series of liquids and such variations in ρ as between 4 % should certainly be genuine.

(3) Other conclusions arrived at in the paper remain valid, as the correction of 0.77 % is a constaht factor throughout. These have been borne out by the later work of Ananthakrishnan (1935).

Regarding the experimental details, the author had always thought it a good plan to avoid errors, as far as practicable, rather than allow them to creep in, later on, making suitable corrections which are always uncertain. On that point, the author's experimental arrangement was superior to that of Ananthakrishnan (1935) who used glass windows fused on to the arms of the cross-tube : there is no meaning in saying that the glass pieces were examined for strain *previous to fusing them* on to the cross-tube, since after fusing they are more likely to develop strains. Further, Ananthakrishnan's cross-tube was definitely of smaller dimensions.

The above considerations show that the author's results were not in the least vitiated by such of the above errors, and still hold good.

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